REPORT Assignment 3 COL724

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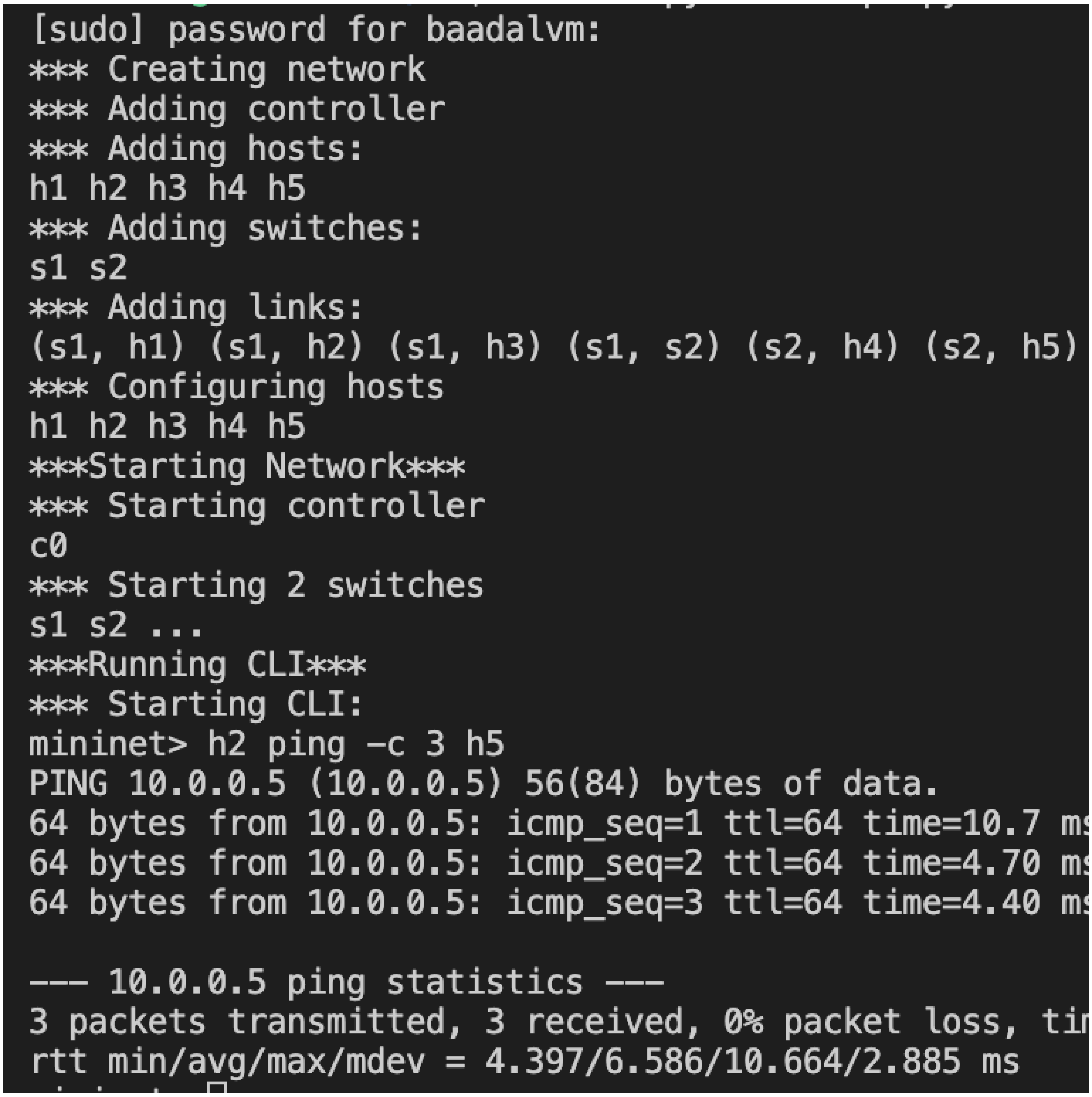
Part 1 -

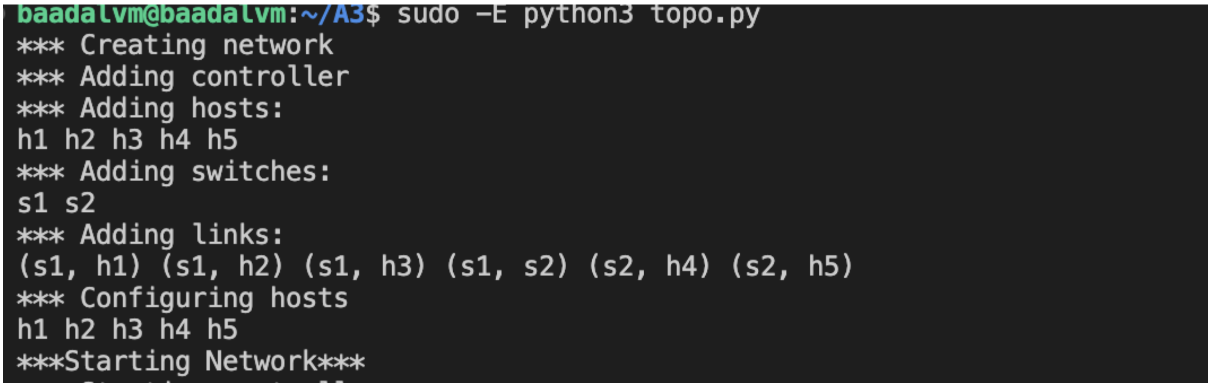
1. Latency values for ping for controller hub
   Latency for simple controller hub is way more than learning switch
   Although for the first ping the latency for learning switch is higher whereas for hub it remains almost the same



```
[sudo] password for baadalvm:
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2 h3 h4 h5
*** Adding switches:
s1 s2
*** Adding links:
(s1, h1) (s1, h2) (s1, h3) (s1, s2) (s2, h4) (s2, h5)
*** Configuring hosts
h1 h2 h3 h4 h5
***Starting Network***
*** Starting controller
c0
*** Starting 2 switches
s1 s2 ...
***Running CLI***
*** Starting CLI:
mininet> h2 ping -c 3 h5
PING 10.0.0.5 (10.0.0.5) 56(84) bytes of data.
64 bytes from 10.0.0.5: icmp_seq=1 ttl=64 time=10.7 ms
64 bytes from 10.0.0.5: icmp_seq=2 ttl=64 time=4.70 ms
64 bytes from 10.0.0.5: icmp_seq=3 ttl=64 time=4.40 ms

--- 10.0.0.5 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, tir
rtt min/avg/max/mdev = 4.397/6.586/10.664/2.885 ms
```

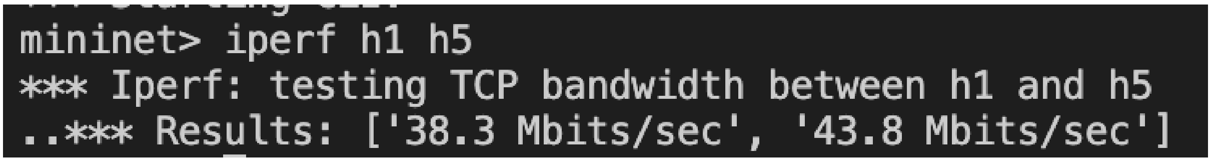
2. Latency values for ping for learning switch



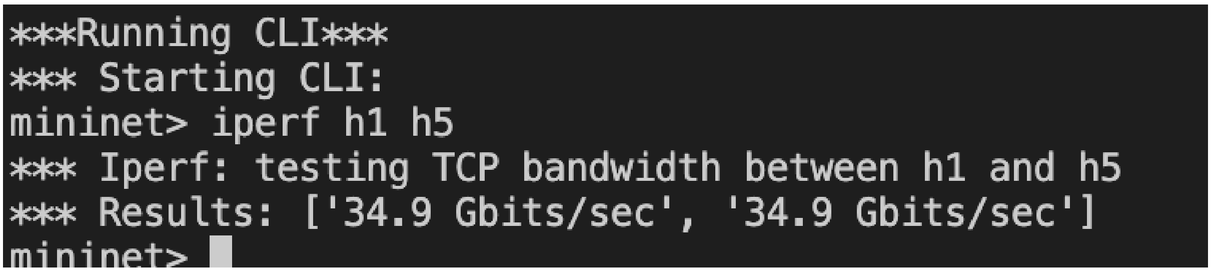
```
baadalvm@baadalvm:~/A3$ sudo -E python3 topo.py
*** Creating network
*** Adding controller
*** Adding hosts:
h1 h2 h3 h4 h5
*** Adding switches:
s1 s2
*** Adding links:
(s1, h1) (s1, h2) (s1, h3) (s1, s2) (s2, h4) (s2, h5)
*** Configuring hosts
h1 h2 h3 h4 h5
***Starting Network***
```

- THROUGHPUT TEST B/W H1 H5

  The hub shares the bandwidth between the ports. A switch, on the other hand, provides dedicated bandwidth to the ports. The number of ports connecting to the device is significantly greater in switches than in the hub. The hub's data transmission speed is quite slow compared to a switch.

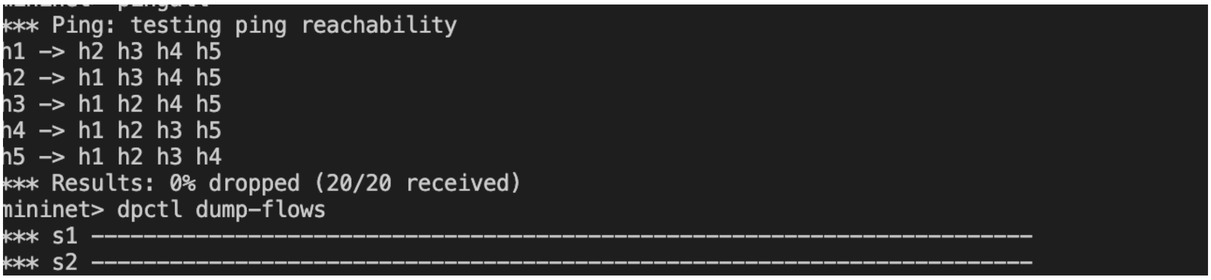


```
*** Starting CLI:
mininet> iperf h1 h5
*** Iperf: testing TCP bandwidth between h1 and h5
..*** Results: ['38.3 Mbits/sec', '43.8 Mbits/sec']
```

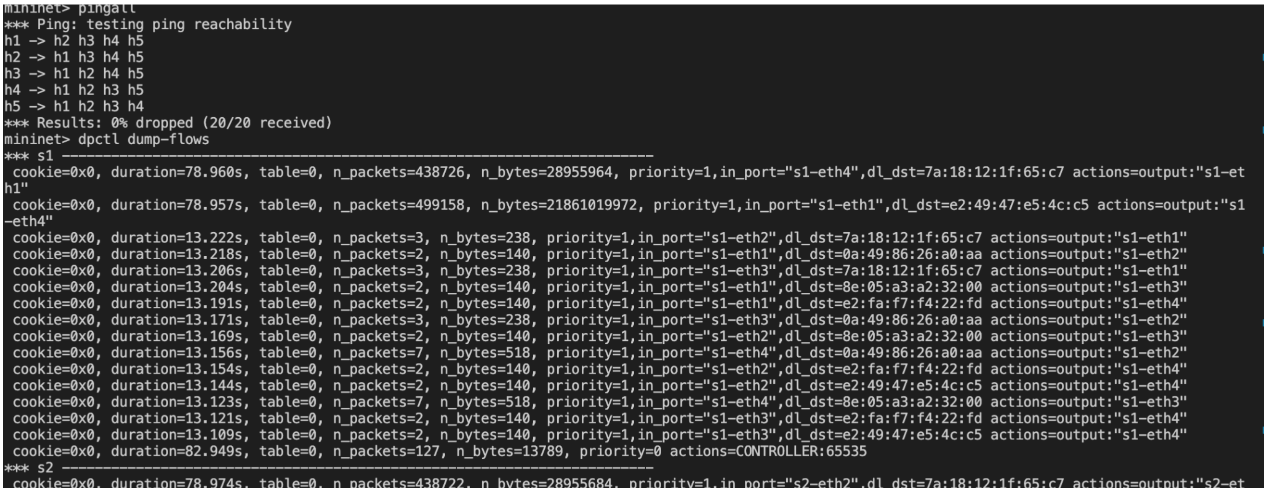


```
***Running CLI***
*** Starting CLI:
mininet> iperf h1 h5
*** Iperf: testing TCP bandwidth between h1 and h5
*** Results: ['34.9 Gbits/sec', '34.9 Gbits/sec']
mininet>
```

- PINGALL and INSTALLED RULES
  As expected no rules are installed in controller hub
  And in learning switch the installed rules are as shown in the latter picture



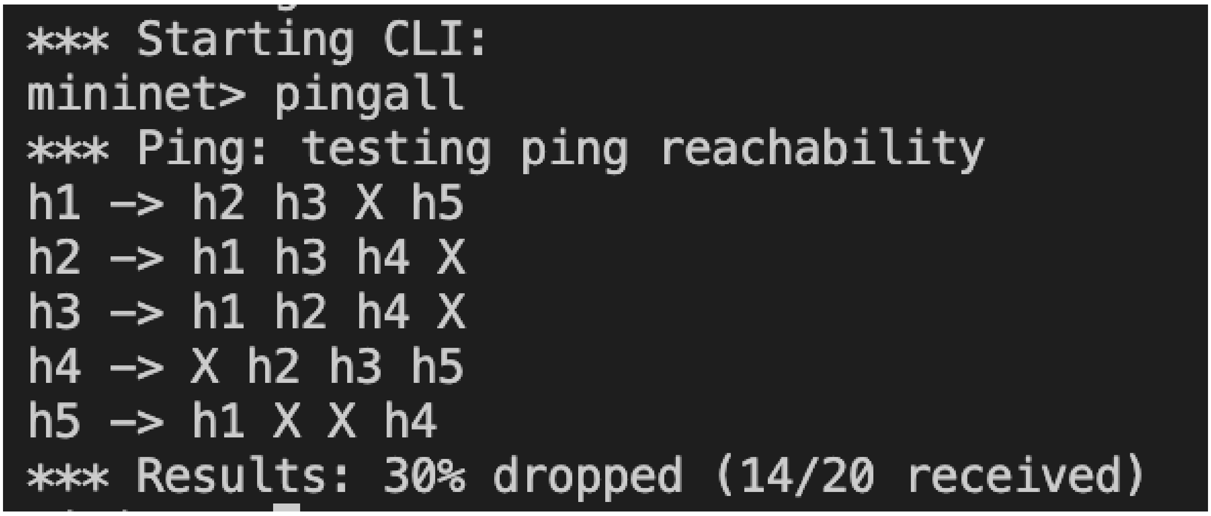
```
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3 h4 h5
h2 -> h1 h3 h4 h5
h3 -> h1 h2 h4 h5
h4 -> h1 h2 h3 h5
h5 -> h1 h2 h3 h4
*** Results: 0% dropped (20/20 received)
mininet> dpctl dump-flows
*** s1 ------------------------------------------------------------------------
*** s2 ------------------------------------------------------------------------
```



```
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3 h4 h5
h2 -> h1 h3 h4 h5
h3 -> h1 h2 h4 h5
h4 -> h1 h2 h3 h5
h5 -> h1 h2 h3 h4
*** Results: 0% dropped (20/20 received)
mininet> dpctl dump-flows
*** s1 ------------------------------------------------------------------------
 cookie=0x0, duration=78.960s, table=0, n_packets=438726, n_bytes=28955964, priority=1,in_port="s1-eth4",dl_dst=7a:18:12:1f:65:c7 actions=output:"s1-et
h1"
 cookie=0x0, duration=78.957s, table=0, n_packets=499158, n_bytes=21861019972, priority=1,in_port="s1-eth1",dl_dst=e2:49:47:e5:4c:c5 actions=output:"s1
-eth4"
 cookie=0x0, duration=13.222s, table=0, n_packets=3, n_bytes=238, priority=1,in_port="s1-eth2",dl_dst=7a:18:12:1f:65:c7 actions=output:"s1-eth1"
 cookie=0x0, duration=13.218s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth1",dl_dst=0a:49:86:26:a0:aa actions=output:"s1-eth2"
 cookie=0x0, duration=13.206s, table=0, n_packets=3, n_bytes=238, priority=1,in_port="s1-eth3",dl_dst=7a:18:12:1f:65:c7 actions=output:"s1-eth1"
 cookie=0x0, duration=13.204s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth1",dl_dst=8e:05:a3:a2:32:00 actions=output:"s1-eth3"
 cookie=0x0, duration=13.191s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth1",dl_dst=e2:fa:f7:f4:22:fd actions=output:"s1-eth4"
 cookie=0x0, duration=13.171s, table=0, n_packets=3, n_bytes=238, priority=1,in_port="s1-eth3",dl_dst=0a:49:86:26:a0:aa actions=output:"s1-eth2"
 cookie=0x0, duration=13.169s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth2",dl_dst=8e:05:a3:a2:32:00 actions=output:"s1-eth3"
 cookie=0x0, duration=13.156s, table=0, n_packets=7, n_bytes=518, priority=1,in_port="s1-eth4",dl_dst=0a:49:86:26:a0:aa actions=output:"s1-eth2"
 cookie=0x0, duration=13.154s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth2",dl_dst=e2:fa:f7:f4:22:fd actions=output:"s1-eth4"
 cookie=0x0, duration=13.144s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth2",dl_dst=e2:49:47:e5:4c:c5 actions=output:"s1-eth4"
 cookie=0x0, duration=13.123s, table=0, n_packets=7, n_bytes=518, priority=1,in_port="s1-eth4",dl_dst=8e:05:a3:a2:32:00 actions=output:"s1-eth3"
 cookie=0x0, duration=13.121s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth3",dl_dst=e2:fa:f7:f4:22:fd actions=output:"s1-eth4"
 cookie=0x0, duration=13.109s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth3",dl_dst=e2:49:47:e5:4c:c5 actions=output:"s1-eth4"
 cookie=0x0, duration=82.949s, table=0, n_packets=127, n_bytes=13789, priority=0 actions=CONTROLLER:65535
*** s2 ------------------------------------------------------------------------
 cookie=0x0, duration=78.974s, table=0, n_packets=438722, n_bytes=28955684, priority=1,in_port="s2-eth2",dl_dst=7a:18:12:1f:65:c7 actions=output:"s2-et
```

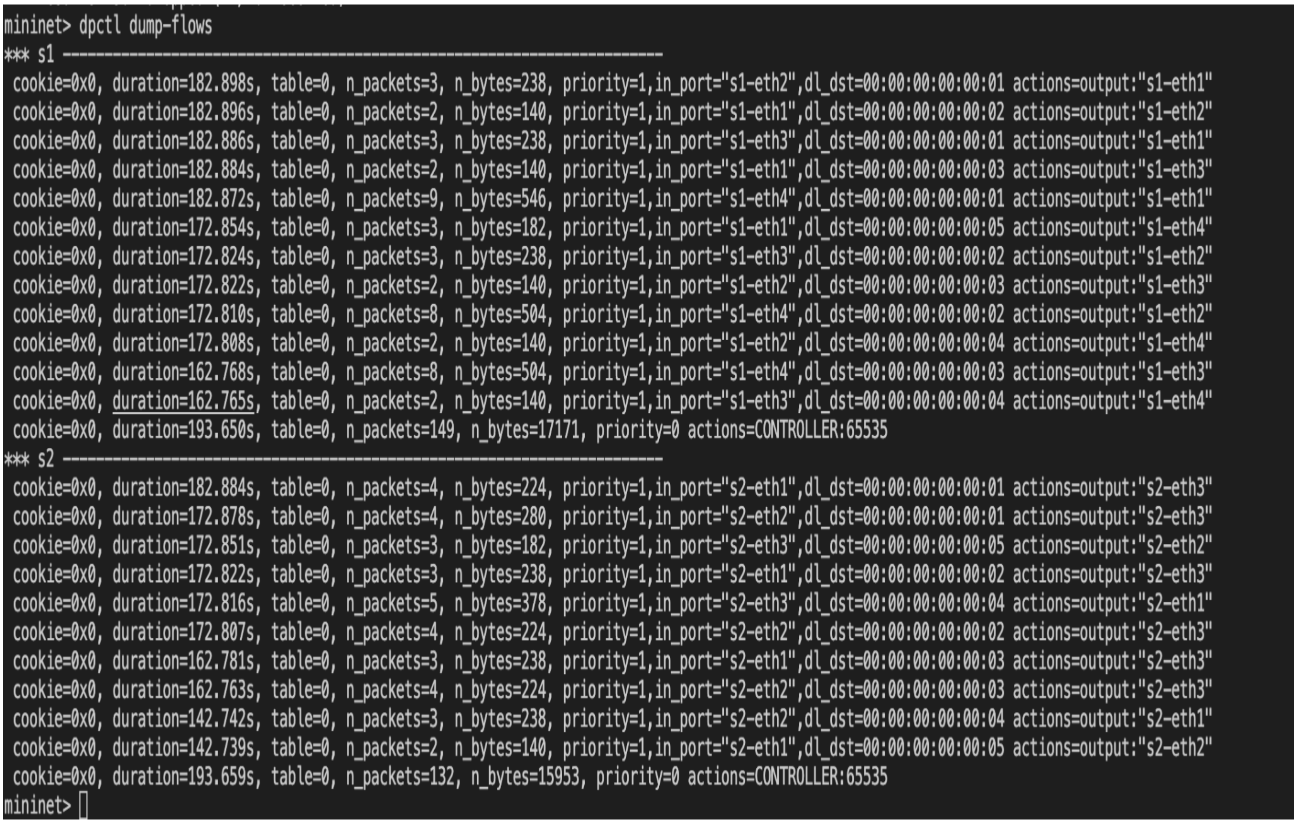
PART 2

- Pingall
- As expected the pingall shows X on the pings for which packets are dropped according to the firewall rules.



```
*** Starting CLI:
mininet> pingall
*** Ping: testing ping reachability
h1 -> h2 h3 X h5
h2 -> h1 h3 h4 X
h3 -> h1 h2 h4 X
h4 -> X h2 h3 h5
h5 -> h1 X X h4
*** Results: 30% dropped (14/20 received)
```

- RULES INSTALLED
  In the installed rules we can see firewall rules as well as the general rules for the switch as well

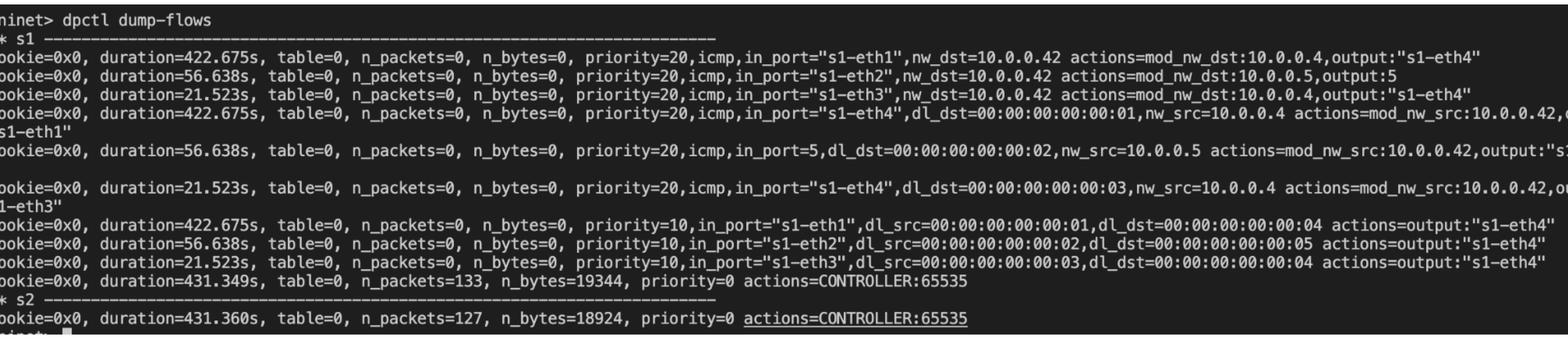


```
mininet> dpctl dump-flows
*** s1 ------------------------------------------------------------------------
 cookie=0x0, duration=182.898s, table=0, n_packets=3, n_bytes=238, priority=1,in_port="s1-eth2",dl_dst=00:00:00:00:00:01 actions=output:"s1-eth1"
 cookie=0x0, duration=182.896s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth1",dl_dst=00:00:00:00:00:02 actions=output:"s1-eth2"
 cookie=0x0, duration=182.886s, table=0, n_packets=3, n_bytes=238, priority=1,in_port="s1-eth3",dl_dst=00:00:00:00:00:01 actions=output:"s1-eth1"
 cookie=0x0, duration=182.884s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth1",dl_dst=00:00:00:00:00:03 actions=output:"s1-eth3"
 cookie=0x0, duration=182.872s, table=0, n_packets=9, n_bytes=546, priority=1,in_port="s1-eth4",dl_dst=00:00:00:00:00:01 actions=output:"s1-eth1"
 cookie=0x0, duration=172.854s, table=0, n_packets=3, n_bytes=182, priority=1,in_port="s1-eth1",dl_dst=00:00:00:00:00:05 actions=output:"s1-eth4"
 cookie=0x0, duration=172.824s, table=0, n_packets=3, n_bytes=238, priority=1,in_port="s1-eth3",dl_dst=00:00:00:00:00:02 actions=output:"s1-eth2"
 cookie=0x0, duration=172.822s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth2",dl_dst=00:00:00:00:00:03 actions=output:"s1-eth3"
 cookie=0x0, duration=172.810s, table=0, n_packets=8, n_bytes=504, priority=1,in_port="s1-eth4",dl_dst=00:00:00:00:00:02 actions=output:"s1-eth2"
 cookie=0x0, duration=172.808s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth2",dl_dst=00:00:00:00:00:04 actions=output:"s1-eth4"
 cookie=0x0, duration=162.768s, table=0, n_packets=8, n_bytes=504, priority=1,in_port="s1-eth4",dl_dst=00:00:00:00:00:03 actions=output:"s1-eth3"
 cookie=0x0, duration=162.765s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s1-eth3",dl_dst=00:00:00:00:00:04 actions=output:"s1-eth4"
 cookie=0x0, duration=193.650s, table=0, n_packets=149, n_bytes=17171, priority=0 actions=CONTROLLER:65535
*** s2 ------------------------------------------------------------------------
 cookie=0x0, duration=182.884s, table=0, n_packets=4, n_bytes=224, priority=1,in_port="s2-eth1",dl_dst=00:00:00:00:00:01 actions=output:"s2-eth3"
 cookie=0x0, duration=172.878s, table=0, n_packets=4, n_bytes=280, priority=1,in_port="s2-eth2",dl_dst=00:00:00:00:00:01 actions=output:"s2-eth3"
 cookie=0x0, duration=172.851s, table=0, n_packets=3, n_bytes=182, priority=1,in_port="s2-eth3",dl_dst=00:00:00:00:00:05 actions=output:"s2-eth2"
 cookie=0x0, duration=172.822s, table=0, n_packets=3, n_bytes=238, priority=1,in_port="s2-eth1",dl_dst=00:00:00:00:00:02 actions=output:"s2-eth3"
 cookie=0x0, duration=172.816s, table=0, n_packets=5, n_bytes=378, priority=1,in_port="s2-eth3",dl_dst=00:00:00:00:00:04 actions=output:"s2-eth1"
 cookie=0x0, duration=172.807s, table=0, n_packets=4, n_bytes=224, priority=1,in_port="s2-eth2",dl_dst=00:00:00:00:00:02 actions=output:"s2-eth3"
 cookie=0x0, duration=162.781s, table=0, n_packets=3, n_bytes=238, priority=1,in_port="s2-eth1",dl_dst=00:00:00:00:00:03 actions=output:"s2-eth3"
 cookie=0x0, duration=162.763s, table=0, n_packets=4, n_bytes=224, priority=1,in_port="s2-eth2",dl_dst=00:00:00:00:00:03 actions=output:"s2-eth3"
 cookie=0x0, duration=142.742s, table=0, n_packets=3, n_bytes=238, priority=1,in_port="s2-eth2",dl_dst=00:00:00:00:00:04 actions=output:"s2-eth1"
 cookie=0x0, duration=142.739s, table=0, n_packets=2, n_bytes=140, priority=1,in_port="s2-eth1",dl_dst=00:00:00:00:00:05 actions=output:"s2-eth2"
 cookie=0x0, duration=193.659s, table=0, n_packets=132, n_bytes=15953, priority=0 actions=CONTROLLER:65535
mininet> 
```

Q. Suppose the network operator intends to implement firewall policies in real time. How can she ensure that the pre-existing rules do not interfere with the firewall policy?
Ans - A priority and evaluation order can be set between rules to avoid interfering.

PART 3 LOAD Balancer

- The installed rules show round robin of packets through h5 and h4.



```
ninet> dpctl dump-flows
* s1 ---------------------------------------------------------------------
ookie=0x0, duration=422.675s, table=0, n_packets=0, n_bytes=0, priority=20,icmp,in_port="s1-eth1",nw_dst=10.0.0.42 actions=mod_nw_dst:10.0.0.4,output:"s1-eth4"
ookie=0x0, duration=56.638s, table=0, n_packets=0, n_bytes=0, priority=20,icmp,in_port="s1-eth2",nw_dst=10.0.0.42 actions=mod_nw_dst:10.0.0.5,output:5
ookie=0x0, duration=21.523s, table=0, n_packets=0, n_bytes=0, priority=20,icmp,in_port="s1-eth3",nw_dst=10.0.0.42 actions=mod_nw_dst:10.0.0.4,output:"s1-eth4"
ookie=0x0, duration=422.675s, table=0, n_packets=0, n_bytes=0, priority=20,icmp,in_port="s1-eth4",dl_dst=00:00:00:00:00:01,nw_src=10.0.0.4 actions=mod_nw_src:10.0.0.42,o
s1-eth1"
ookie=0x0, duration=56.638s, table=0, n_packets=0, n_bytes=0, priority=20,icmp,in_port=5,dl_dst=00:00:00:00:00:02,nw_src=10.0.0.5 actions=mod_nw_src:10.0.0.42,output:"s1

ookie=0x0, duration=21.523s, table=0, n_packets=0, n_bytes=0, priority=20,icmp,in_port="s1-eth4",dl_dst=00:00:00:00:00:03,nw_src=10.0.0.4 actions=mod_nw_src:10.0.0.42,ou
1-eth3"
ookie=0x0, duration=422.675s, table=0, n_packets=0, n_bytes=0, priority=10,in_port="s1-eth1",dl_src=00:00:00:00:00:01,dl_dst=00:00:00:00:00:04 actions=output:"s1-eth4"
ookie=0x0, duration=56.638s, table=0, n_packets=0, n_bytes=0, priority=10,in_port="s1-eth2",dl_src=00:00:00:00:00:02,dl_dst=00:00:00:00:00:05 actions=output:"s1-eth4"
ookie=0x0, duration=21.523s, table=0, n_packets=0, n_bytes=0, priority=10,in_port="s1-eth3",dl_src=00:00:00:00:00:03,dl_dst=00:00:00:00:00:04 actions=output:"s1-eth4"
ookie=0x0, duration=431.349s, table=0, n_packets=133, n_bytes=19344, priority=0 actions=CONTROLLER:65535
* s2 ---------------------------------------------------------------------
ookie=0x0, duration=431.360s, table=0, n_packets=127, n_bytes=18924, priority=0 actions=CONTROLLER:65535
```

- If you were to implement a load balancing policy that considers the load on these servers, what additional steps would you take? [No need to implement it in the code, just describe the additional steps.]

- We can do a weighted round robin algorithm by taking into account weights corresponding to server load
- Some load threshold could be set and rules be set acc to that